

CAT.04 34

## FOREWORD

Work performed on contract tasks 8 through 16, since December 1970, is summarized in this report.

Technical review of the work performed under this contract was done by Mr. L.B. Hall, NASA Planetary Quarantine Officer, with the assistance of Mrs. S. Gallagher, Contract Monitor, and Dr. D. Fox, Planetary Quarantine Officer for the Viking Program, until his reassignment on August 15, 1971.

Exotech's work was directed by Mr. S. Schalkowsky, President and Technical Director of Exotech Systems, Inc.

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## INTRODUCTION

Contract NASw-2062 was initiated on March 3, 1970 to provide NASA's Planetary Quarantine Office with analytical and technical support, in the development and implementation of planetary quarantine requirements, applicable to space flight programs. The scope of the work to be performed under the contract comprised the first seven tasks listed in Table 1.

Modification No. 1, issued April 27, 1971, extended the support effort through December 31, 1971, adding tasks 8 through 15. A subsequent modification, effective December 30, 1971, amended five of these later tasks and added task 16.

Work performed on the first seven tasks of the contract (from March 3, 1970 through December 31, 1970) was reported in a set of documents which were submitted to the Planetary Quarantine Office during that period. These reports are listed in Table II.

**TABLE I**  
**TASK DESCRIPTION**

<u>Task No.</u>	<u>Titles</u>
1	Evaluation of Planetary Quarantine Requirements
2	Quarantine Document System for Planetary Flight Missions
3	Evaluation of Flight Project Quarantine Plans
4	Planning of Supporting Technology Transfer
5	Analysis of Microbial Release Probabilities
6	Analytical Models for the Design of Heat Sterilization Cycles
7	Organic Constituent Inventory for Planetary Flight Missions
8	Evaluation of Planetary Quarantine Requirements (Extended Effort of Task 1 and Expanded Review Requirements)
9	Quarantine Document System for Planetary Flight Missions (Extended Effort of Task 2)
10	Microbial Contamination Logs for Venus and Mars
11	Evaluation of Flight Project Quarantine Plans (Extended effort of Task 3 to include recently approved missions)
12	Supporting Technology Transfer
13	Specification of the Probability of Microbial Release (Extended effort of Task 5 to include the development and justification of specified parameter values.)
14	Estimation of Encapsulated Microbial Burden
15	Supporting Analysis of Planetary Quarantine Sterilization Parameter
16	Support for Technical Meetings

TABLE II

## TASK REPORTS 1 THROUGH 7

Reference Task No.	Title of Report	Date of Publication	Identification Exotech Report No.
1	Implications of 1970 COSPAR Recommendations on PQ Requirements for Mars Missions	June 1970	TRSR70-42
	Implications of Change in Probability of Microbial Growth for Mars (July 1970 SSB Meeting)	Sept. 1970	TR71-04
2	Quarantine Document System Operations Manual	Dec. 1970	TR71-13
5	Estimation of Microbial Release Probabilities from a Martian Lander	July 1970	TR70-02
	Analysis of Microbial Release Probabilities	Dec. 1970	TR71-11
6	Optimization of Oven Heating Profiles in Spacecraft Sterilization	Dec. 1970	TR71-12
	Estimation of Planetary Contamination Probabilities by Non-Landing Vehicles	Dec. 1970	TR71-10
	Mathematical Basis for a Diffusion Model of Microbial Spore Destruction	Dec. 1970	TR71-15
	Analytical Basis for the Estimation of Planetary Contamination by Terrestrial Micro-Organisms	Dec. 1970	TR71-14
7	Organic Constituent Inventory for Planetary Flight Missions	Dec. 1970	TR71-16
1 - 7	Planning, Evaluation and Analytical Studies in Planetary Quarantine and Spacecraft Sterilization. Final Report	Dec. 1970	TR71-17

## PROJECT SUMMARY

NASA's Planetary Quarantine Office is charged with responsibility for establishing contamination constraints on planetary space missions. They approve flight project plans which comply with these constraints, and certify spacecraft to be microbiologically acceptable for launch. Planning, evaluation, and analysis activities are essential elements of support for the Planetary Quarantine Office in carrying out these responsibilities.

The objective of this contract was to supply that support to the Planetary Quarantine Office in the conduct of these activities. To facilitate dissemination of the results of this work, individual subjects have been summarized in separate reports, and published under separate covers. Some of these reports and memoranda have been submitted to NASA in the course of the contract period; others are being issued and submitted in conjunction with this final report. Table III summarizes the reports prepared, under the contract, since December 1970. These reports are grouped in accordance with the applicable Task numbers.

Table IV summarizes papers presented and pertinent meetings held since December 1970.



TABLE III

## SUMMARY OF REPORTS PUBLISHED

Reference Task No.	Title of Report	Date of Publication	Identification Exotech Report No.
8	Summary Report — Input on PQ Program of Recent SSB Actions	Feb. 1972	
9	Quarantine Document System Indexing Procedure	Mar. 1972	TR72-09
10	Microbial Contamination Log for Mars (Revised)	May 1972	
	Microbial Contamination Log for Mars (Revised)	Dec. 1972	
	Microbial Contamination Log for Venus (Revised)	May 1972	
	Microbial Contamination Log for Venus (Revised)	Dec. 1972	
11	Memoranda Relating to Document Review		
12	Removal of Microbial Contamination Through Filtration	Apr. 1972	TR72-10
	Decontamination with Ethylene Oxide	Apr. 1972	TR72-11
13	Estimation of Microbial Release Probabilities	Apr. 1972	TR72-12
14	Estimation of Encapsulated Microbial Burden	Apr. 1972	TR72-13
15	Safety Margins in the Implementation of Planetary Quarantine Requirements	Apr. 1972	TR72-14

TABLE IV  
PAPERS PRESENTED AND MEETINGS ATTENDED

Reference Task No.	Title and/or Location
8	<p>January 12, 1971, LaRC — Meeting with Viking project on assignment of values for <math>P(r)</math>, <math>D</math> and buried load.</p> <p>February 24, 1971, NASA — Meeting with MM '71 on evaluation of <math>P(e)</math>, <math>P(t)</math>, <math>P(vt)</math> and <math>P(uv)</math>.</p> <p>January 18, 1972, PQAP, Cape Kennedy — Presentation of recommendations for <math>P(uv)</math>, <math>P_B(r l)</math>, <math>P_M(r l)</math>, <math>P_S(r l)</math>, <math>P_B(re s)</math>, <math>P_M(re s)</math>, <math>P_S(re s)</math></p>
10	<p>June 1971 — Microbial Contamination Log for Planet Mars.</p> <p>June 1971 — Microbial Contamination Log for Planet Venus.</p> <p>December 1971 — Microbial Contamination Log for Planet Mars.</p> <p>December 1971 — Microbial Contamination Log for Planet Venus.</p>
11	<p>March 24-25, 1971, LaRC — Viking Launch Capsule (VLC) recontamination probability.</p> <p>June 1, 1971, LaRC — Viking Launch Capsule (VLC) bioshield release.</p>
12	<p>September 20, 1971, Denver — Workshop session with review panel board on state of technology surveys of Microbial Filtration and Ethylene Oxide Decontamination.</p>
13	<p>June 18, 1971, Spacecraft Sterilization Seminar, Seattle, Washington — Presentation by E.J. Bacon on Estimation of the Probability of Release of Buried Microbial Burden.</p> <p>September 21, 1971, PQAP, Denver — Development of Numerical Values for <math>P(r)</math> for Mars Based Upon Mars Environmental Model.</p>

(continued)

TABLE IV (con't.)

## PAPERS PRESENTED AND MEETINGS ATTENDED

Reference Task No.	Title and/or Location
14	<p>February 2-3, 1971, PHS/Phoenix - Meeting with Dr. M. Favero and laboratory staff to develop test protocol for measurement of buried microbial burden.</p> <p>April 22, 1971, PQAP, Atlanta, Georgia - Report of status of cooperative empirical/analytical program for development of numerical recommendations for the estimation of buried biological burden.</p> <p>June 18, 1971, Spacecraft Sterilization Seminar, Seattle, Washington - Presentation by R.G. Lyle on, "Estimation of Buried Burden."</p> <p>June 21, 1971, PQAP, Seattle, Washington - Report of status of cooperative empirical/analytical program for development of numerical recommendations for the estimation of buried biological burden.</p> <p>September 21, 1971, PQAP, Denver - Results of combined empirical/analytical program and presentation of recommendations for estimation of buried biological burden.</p>
15	<p>June 18, 1971, Spacecraft Sterilization Seminar, Seattle, Washington - Presentation by S. Schalkowsky on a method for combining numerical values of probabilistic terms without undue conservation or bias.</p>
General	<p>June 22, 1971, COSPAR - Hall, L.B.; Fox, D.G.; and Bacon, E.J.: "Development of Planetary Quarantine in the United States." COSPAR Paper #L.1.1</p>

## TASK SPECIFICS

The discussion which follows provides a summary of work performed under Tasks 8 through 16, with emphasis on material not covered in the separate reports of Table III. Conclusions and recommendations are included in the discussion of the individual tasks.

### Task 8. Evaluation of Planetary Quarantine Requirements

This task supported the development of NASA Planetary Quarantine policies, both at the Space Science Board and at meetings of panels of the Committee on Space Research (COSPAR). Its objective was to provide supporting technical material, analysis and evaluation for Space Science Board review meetings of planetary quarantine requirements, relative to international agreements of COSPAR.

In preparation for review meetings by the Space Science Board, and by the pertinent COSPAR committees, analyses were performed of required modifications in planetary quarantine policies, or constraints, in the light of preceeding experience in flight project implementation, or of new data from applicable technologies. The results of such analyses were compiled in a form which would facilitate an evaluation by the Space Science Board, consistent with the needs of the planetary quarantine program. Following the review meetings by the Space Science Board and COSPAR, the effects on flight project implementation of recommendations, made by these committees, were evaluated. This included consideration of the allocation of contamination probabilities, microbiological assay and control policies and effects on sterilization requirements imposed on flight projects.

Activity under this task centered on the policy revisions effected during the calendar year 1971. In an effort to take advantage of recently acquired

scientific knowledge bearing upon planetary quarantine objectives and requirements, the PQO in July 1971 identified the following items for special attention:

- Relaxation of lunar contamination control policy.
- Review of the value of P(g) for Venus.
- Reconciliation of SSB and COSPAR recommendations for safeguarding the outer planets.
- Review of the need for contamination control for Mercury missions.

The consultation of the Space Science Board of the National Academy of Sciences, which provides technical and policy advice to the PQO, was asked in August 1971 to review these matters.

As a consequence of this approach and subsequent actions, NASA established a revised PQ Policy (Appendix A) based upon the recommendations submitted for SSB review, and the SSB, in an attempt to provide a realistic base for comparative analysis, undertook a detailed review of the impact on the Viking program of existing proposed and potential relaxations in PQ constraints. This review considered the cost in dollars, and in reliability assurance, of the levels of contamination control necessary to protect (1) the planet, and (2) the scientific objectives.

To assist in this policy re-evaluation, ESI compiled an historical background to the issues under consideration, and analyzed the impact of several possible courses of action. Supportive material was prepared for presentation by the PQO to members of the SSB on August 20-21, 1971. A meeting with members of the SSB, MMC, JPL, the flight project group, and PQO was attended in Washington in January 1972, in preparation for the Viking project presentation to the SSB in Denver on February 3-4, 1972.

The results of the SSB's review of the impact of PQ on the Viking mission have not yet been released. When these recommendations are made, further review is indicated to evaluate their effect on ongoing and planned planetary programs.

#### Task 9. Quarantine Document System for Planetary Flight Missions

The review by NASA Headquarters of the various planetary quarantine plans on flight projects requires the time-limited availability of special documents, such as requirements documents, flight project specifications, and procedures. Since only a very limited time is available to NASA Headquarters for review and approval of the various plans, and for responding to anticipated requests for deviations from these plans, an effective collection and retrieval system of this specialized information is required. The Quarantine Document System (QDS) fills this need. This task comprised the expansion and continued operation of QDS.

The collection now numbers 325 documents comprising reports, plans, memos, letters, and other material relating to flight program quarantine requirements, and plans for compliance with these requirements. A thesaurus of terms commonly used in requesting information has been used in indexing. ESI report TR72-09 describes this indexing function, and has been issued to assist QDS users in requesting information retrievals.

#### Task 10. Preparation of Microbial Contamination Logs for Planets Mars and Venus

The requirement for a systematic monitoring of the extent to which space exploration was effecting international contamination control agreements was voiced at the COSPAR Congress at Prague in 1969, which

recommended cumulative contamination accounting for the planets Mars, Venus and Jupiter. The microbial contamination logs respond to this request by listing, for all known space missions to the specified planet, reported data pertinent to the estimation of contamination probability.

Logs previously prepared for Mars and Venus were updated in May and December 1971. The former were delivered to the COSPAR Panel during the Congress at Seattle in July 1971.

#### Task 11. Evaluation of Flight Project Quarantine Plans

The objective of this task was to support the evaluation by the NASA Planetary Quarantine Office of flight project quarantine plans, in terms of their responsiveness to NASA requirements, and compatibility with accepted practices for their implementation. During the contract period, the following plans were reviewed under this task:

- Mariner Mars 1971 Prelaunch Analysis Probability of Planetary Contamination, PD 610-18 Part II, Draft dated 12 January 1971.
- Planetary Explorer/Venus Section 7 of Phase A Report, relating to planetary quarantine aspects influencing mission feasibility and costs, undated.
- NASA/Ames — Spacecraft Component Survivability During Entry Into the Jovian Atmosphere, by B.L. Swenson, November 20, 1970.
- The Pioneer F Prelaunch Analysis of Probability of Planetary Contamination (NASA/Ames Document No. PC-296) was reviewed, and preliminary comments were forwarded by memo to the Planetary Quarantine Officer on July 30, 1971.

A JPL document<sup>1</sup> presenting the results of a preliminary analysis of Planetary Quarantine constraints on Mariner Venus-Mercury 1973 was reviewed.

- The revised "Viking Planetary Quarantine Provisions" document M75-127-1 was reviewed.
- A report of the Goody Committee on "Quarantine Considerations for Outer Planet Missions" was reviewed, and comments are in preparation.

Results of these reviews were submitted to the Planetary Quarantine Office, Code SB, in accordance with the reporting requirements of Article III.

#### Task 12. Planning of Supporting Technology Transfer

The purpose of this task was to facilitate the effective transfer and utilization of technology developed by the NASA Planetary Quarantine Office. The task relates to two objectives at the NASA Headquarters Planetary Quarantine Office, viz., (1) to provide support to flight projects, in terms of the development and the application of pertinent technologies, and (2) to facilitate the transfer of NASA bioscience technology to non-NASA users.

The major effort under this task focused on specific technological topics having significant transfer potential. Two subjects of current interest to both space flight projects, as well as to non-space users, were treated in some detail. These are:

Contamination Control Through Filtration of Microorganisms  
Contamination Control by Use of Ethylene Oxide.

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<sup>1</sup>Stavro, W.: Preliminary Analysis on the Effect of Planetary Quarantine on Venus-Mercury 1973. JPL Interoffice Memorandum No. 392.2-229, May 28, 1971.



Pertinent information on both subjects was collected from space and non-space activities. Compiled data was reviewed with a panel of experts experienced in the needs of space and non-space users. The two documents, TR72-10 and TR72-11, (see Table III), which review the state of the technology, have been issued.

### Task 13. Analysis of Microbial Release Probabilities

The objective of this task was to develop a recommended approach for the inclusion of more realistic values for this factor in flight project implementation of planetary quarantine requirements. In the past, flight projects have been required to work with conservative or "worst case" values, for the probability that terrestrial microorganisms contained on or in spacecraft which encountered a planet would be released in a viable state. This approach has resulted in microbial control programs which may be far in excess of needs.

This task reviewed the current status in estimating the probability that terrestrial organisms on planetary landing spacecraft would be released in a viable state onto the surface of the planet. It identified the principal areas of uncertainty, applied empirical knowledge to reduce these uncertainties, and recommended values for use by flight projects. The work was reviewed by PQAP in Denver on September 21, 1971, and in Cape Kennedy on January 18-20, 1972. PQO approved values (see Appendix B) were issued in February 1972. An Interim Report TR72-12 summarizes the results of this work.

#### Task 14. Estimation of the Encapsulated Microbial Burden

The objective of this task was to develop a methodology for obtaining better estimates of the microbial burden encapsulated in spacecraft materials. This objective was attained and the results of the work performed in this task are evidenced in the Planetary Quarantine Office approved parameter evaluation report on  $d_v(0)$  issued in February 1972 (see Appendix B).

The methodology applied to obtain the estimate of buried bioburden was presented in detail at the Planetary Quarantine Seminar and the PQAP meeting in June 1971. This methodology was found acceptable to PQAP. We then completed the analysis of experimental data obtained by the Phoenix Laboratory and developed a model of the volume of sources of buried bioburden in a Planetary Flight Mission Vehicle.

All available base line data obtained from assaying piece parts using the biogrinder technique and from reports of earlier investigations was accounted for in our analyses. The Jet Propulsion Laboratory provided documentation on the materials and piece parts comprising the Mariner Mars '71 vehicles for our use in estimating the volume of sources of encapsulated bioburden. Our analysis of this data provided the additional inputs needed to develop specific estimated values of the parameter  $d_v(0)$  corresponding to a broad range of confidence levels.

The results of the work performed under this task were reported to, and reviewed by, PQAP in September 1971 and January 1972. This work is documented in detail in interim report ESI TR72-13.

### Task 15. Supporting Analysis of Planetary Quarantine Sterilization Parameters

This task includes analyses to support the specification of flight project requirements, the review of flight project implementation plans, and the recommendations for changes in PQ constraints. In addition to analyses supporting the tasks summarized in the previous paragraphs, the following work was performed:

- An analysis was initiated of microbial sterilization during entry into the atmospheres of Mars and the outer planets.
- The evaluation of safety margins in the use of PQ parameters was extended. An interim report (see Table III) has been issued.
- An analytical model was developed for the estimation of buried contamination under varied experimental conditions.
- A preliminary analysis of the various parameters involved in lander recontamination and their interrelation was undertaken.
- An analysis of the distribution of D values was undertaken.
- A review of key PQ parameters was performed.

In the review of the key parameters, pertinent laboratory test data were analyzed, to develop recommendations for the specification of numerical values for the following parameters:

- (1) Probability of Microbial Survival of Interplanetary Ultraviolet Radiation.
- (2) Probability of Microbial Survival of Interplanetary Vacuum-Temperature.

- (3) Probability of Release of Buried Contamination Caused by Erosion.
- (4) Probability of Release of Buried Contamination Caused by Impact.
- (5) Probability of Release of Mated Surface Contamination Caused by Erosion.
- (6) Probability of Release of Mated Surface Contamination Caused by Impact.
- (7) Probability of Release of Surface Contamination Caused by Erosion.
- (8) Probability of Release of Surface Contamination Caused by Impact.
- (9) Number of Microorganisms Encapsulated in Spacecraft Material.

Specifications have now been issued for these parameters (see Appendix B) to aid flight projects in complying with PQ constraints.

#### Task 16. Support for Technical Meetings

This task focused the support requested by the PQO, in conjunction with meetings in January 1972 of the PQAP, and the Spacecraft Sterilization Technology Seminar. Details of this support have been reported in earlier task writeups.

## APPENDIX A

### REVISED PLANETARY QUARANTINE POLICY



(E) Bucan

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION  
WASHINGTON, D.C. 20546

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REPLY TO  
ATTN OF: SL

August 24, 1971

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TO: Distribution

SUBJECT: Revised and New Planetary Quarantine  
Policies

Transmitted herewith is self explanatory material bearing on the revision of existing and the establishment of new National Aeronautics and Space Administration Planetary Quarantine policy.

These policies became effective with the signature of the letter to Dr. Townes by the Associate Administrator/OSSA on August 12, 1971. They should be integrated into pertinent programs as they apply. This office will be glad to attempt to clarify any questions you may have.

While the Space Science Board may see fit to recommend revisions of these policies they have given no evidence of wishing to do so.

*Lawrence B. Hall*  
Lawrence B. Hall  
Planetary Quarantine Officer  
Planetary Programs  
Office of Space Science  
and Applications

## PROPOSED PLANETARY QUARANTINE POLICIES — 1971

### 1. MARS—Probability of Growth ( $P_G$ ) of Terrestrial Organisms

In its most recent evaluation, the Space Science Board established a value of  $P_G = 3 \times 10^{-9}$  with 50% confidence and  $P_G = 10^{-4}$  with 0.999 confidence. It recommended to NASA that it use the conservative value of  $P_G = 10^{-4}$  but that the large safety margin inherent in this choice should not be duplicated in other parameters.

From an operational point of view, it is preferred to use a uniform approach to the control of safety margins. We will therefore use a value of  $P_G = 10^{-6}$  and a correspondingly appropriate methodology for providing reasonable, but not excessive safety margins in the evaluation and implementation of other planetary quarantine factors.

### 2. VENUS—Probability of Growth ( $P_G$ ) of Terrestrial Organisms

- a. Surface:  $P_G = 0$
- b. Outer Atmosphere:  $P_G = 10^{-9}$

### 3. MERCURY

This planet will not be considered of biological interest and therefore not subject to planetary quarantine constraints.

### 4. OUTER PLANETS

Planetary quarantine requirements will be established using the same parameters as applied to Mars.

## 5. BUS DEFLECTION

Bus deflection will not be considered an independent constraint, but treated as part of the evaluation of planetary contamination for a particular flight mission. Bus deflection trajectories will therefore be acceptable when the resultant overall probability of contamination can be demonstrated to be within the allocation for the mission.

## 6. APOLLO

The identification of organisms on outbound Apollo missions will be discontinued.



## APPENDIX B

### PARAMETER VALUE SPECIFICATIONS

PLANETARY QUARANTINE PARAMETER VALUE

PARAMETER TITLE:

PROBABILITY OF RELEASE OF BURIED ORGANISMS UNDER NON-  
NOMINAL LANDING CONDITIONS

PARAMETER DEFINITION:

Assuming non-nominal landing velocities of the spacecraft on Mars, probability that a randomly selected organism encapsulated within spacecraft materials will be removed by the combined mechanisms of fracture during impact and subsequent erosion, and deposited on the surface of the planet in a viable state.

APPLICABLE SOURCE:

All encapsulated microorganisms on the spacecraft.

CONSTRAINTS:

Conditional that the cumulative probability of events leading to impact at velocities more than 1,000 feet/sec is at least five decades smaller than the cumulative probability of all events leading to non-nominal landing velocities.

This value was derived assuming the use of heat sterilization. If processes are proposed that do not include heat, the value must be reassessed to assure its applicability for the proposed usage.

This value is based upon environmental conditions predicted by preliminary results from the Mariner 9 mission. Should later data suggest that these predictions be changed, the value of this parameter may have to be revised.

REFERENCES:

PQAP reviews on January 18-19, 1972 at Cape Kennedy, Florida.

Lawrence B. Hall  
PLANETARY QUARANTINE OFFICER

MAR 2 1972  
DATE

NOTE: THE ABOVE DATA SUPERCEDES PREVIOUSLY PUBLISHED DATA ISSUED BY THIS OFFICE. PARAMETER VALUES DERIVED AS STATED ABOVE WILL BE ACCEPTED BY THE PLANETARY QUARANTINE PROGRAM IF USED IN THE MISSION P.Q. ANALYSIS AS DEFINED HEREIN.

PLANETARY QUARANTINE PARAMETER VALUEPARAMETER TITLE:

PROBABILITY OF RELEASE OF MATED ORGANISMS UNDER NON-NOMINAL LANDING CONDITIONS

PARAMETER DEFINITION:

Assuming non-nominal landing velocities of the spacecraft on Mars, probability that a randomly selected mated organism anywhere in the spacecraft will be removed by the combined mechanisms of fracture during impact and subsequent erosion, and deposited on the surface of the planet in a viable state.

APPLICABLE SOURCE:

All mated organisms on the landing vehicle.

CONSTRAINTS:

Conditional that the cumulative probability of events leading to impact at velocities more than 1,000 feet/sec is at least five decades smaller than the cumulative probability of all events leading to non-nominal landing velocities.

This value was derived assuming the use of heat sterilization. If processes are proposed that do not include heat, the value must be reassessed to assure its applicability for the proposed usage.

This value is based upon environmental conditions predicted by preliminary results from the Mariner 9 mission. Should later data suggest that these predictions be changed, the value of this parameter may have to be revised.

REFERENCES:

PQAP review on January 18-19, 1972 at Cape Kennedy, Florida.

*Lawrence B. Hall*

PLANETARY QUARANTINE OFFICER

MAR 2 1972

DATE

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$P_M(rc|s)$

SYMBOL

MARS

MISSION SPECIFIC

$1 \times 10^{-3}$

UPPER

ACCEPTABLE

LOWER

PLANETARY QUARANTINE PARAMETER VALUE

PARAMETER TITLE:

PROBABILITY OF RELEASE BY EROSION OF MATED  
MICROORGANISMS UNDER SOFT LANDING CONDITIONS

PARAMETER DEFINITION:

Assuming soft landing of a spacecraft on Mars, probability that a randomly selected mated microorganism within a defined source will be removed from that source by erosion and deposited on the surface of the planet in a viable state.

APPLICABLE SOURCE:

All organisms on mated surfaces of the spacecraft.

CONSTRAINTS:

This value was derived assuming the use of heat sterilization. If processes are proposed that do not include heat, the value must be reassessed to assure its applicability for the proposed usage.

- This value is based upon environmental conditions predicted by preliminary results from the Mariner 9 mission. The value of this parameter may have to be revised on the basis of further results from the Mariner 9 mission.

REFERENCES:

PQAP review on January 18-19, 1972 at Cape Kennedy, Florida.

*Lawrence B. Hall*  
PLANETARY QUARANTINE OFFICER

MAR 2 1972

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PLANETARY QUARANTINE PARAMETER VALUE

PARAMETER TITLE:

PROBABILITY OF RELEASE OF SURFACE ORGANISMS UNDER NON-NOMINAL LANDING CONDITIONS

PARAMETER DEFINITION:

Assuming non-nominal landing velocities of the spacecraft on Mars, probability that a randomly selected organism located on a surface will be removed by the combined mechanisms of impact and subsequent aeolian erosion and deposited on the surface of the planet in a viable state.

APPLICABLE SOURCE:

All surface organisms on the various spacecraft surfaces.

CONSTRAINTS:

Conditional that the cumulative probability of events leading to impact at velocities more than 1,000 feet/sec is at least five decades smaller than the cumulative probability of all events leading to non-nominal landing velocities.

This value was derived assuming the use of heat sterilization. If processes are proposed that do not include heat, the value must be reassessed to assure its applicability for the proposed usage.

This value is based upon environmental conditions predicted by preliminary results from the Mariner 9 mission. Should later data suggest that these predictions be changed, the value of this parameter may have to be revised.

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PLANETARY QUARANTINE PARAMETER VALUE

PARAMETER TITLE:

PROBABILITY OF RELEASE BY EROSION OF SURFACE ORGANISMS  
UNDER SOFT LANDING CONDITIONS

PARAMETER DEFINITION:

Assuming soft landing of a spacecraft on Mars, probability that a randomly selected surface organism within a defined source will be removed from that source by aeolian erosion and deposited on the surface of the planet in a viable state.

APPLICABLE SOURCE:

All microorganisms on spacecraft surfaces.

CONSTRAINTS:

Selection of a particular value within the above bounds shall be based on the relative accessibility of the surfaces under consideration to aeolian erosion. A value of 1 shall be used for exposed, external surfaces. Smaller values can be justified for surfaces which are shielded from exposure by protective material. Interior surfaces on remotely located containers with covers of erosion-resistant materials can use values near the lower limit.

This data was derived assuming the use of heat sterilization. If processes are proposed that do not include heat, the value must be reassessed to assure its applicability for the proposed usage.

This value is based upon environmental conditions predicted by preliminary results from the Mariner 9 mission. The value of this parameter may have to be revised on the basis of further results from the Mariner 9 mission.

REFERENCES:

PQAP review on January 18-19, 1972 at Cape Kennedy, Florida.

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MAR 2 1972  
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PLANETARY QUARANTINE PARAMETER VALUEPARAMETER TITLE:

AVERAGE ENCAPSULATED MICROBIAL DENSITY

PARAMETER DEFINITION:

The average number of microorganisms buried inside non-metallic unit volume of the spacecraft. The value does not take into consideration any burden reduction during spacecraft manufacture, assembly and test.

APPLICABLE SOURCE:

Total volume of non-metallic materials in the spacecraft; or a major part thereof containing piece parts, and non-metallic materials of similar properties to the entire spacecraft.

CONSTRAINTS:

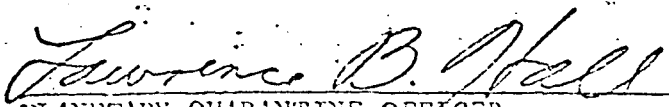
To apply this parameter, the total volume of non-metallic material must be derived.

This value was derived assuming the use of heat sterilization. If processes are proposed that do not include heat, the value must be reassessed to assure its applicability for the proposed usage.

REFERENCES:

PQAP review on September 28, 1971 in Denver, Colorado

MAR 2 1972

  
PLANETARY QUARANTINE OFFICER

DATE

NOTE: THE ABOVE DATA SUPERCEDES PREVIOUSLY PUBLISHED DATA ISSUED BY THIS OFFICE. PARAMETER VALUES DERIVED AS STATED ABOVE WILL BE ACCEPTED BY THE PLANETARY QUARANTINE PROGRAM IF USED IN THE MISSION P.Q. ANALYSIS AS DEFINED HEREIN.

P(uv)  
SYMBOL

MARS  
MISSION SPECIFIC

1  
UPPER

see  
below  
ACCEPTABLE

<10<sup>-4</sup>  
LOWER

PLANETARY QUARANTINE PARAMETER VALUE

PARAMETER TITLE:

PROBABILITY OF SURFACE ORGANISMS SURVIVING ULTRA-VIOLET RADIATION

PARAMETER DEFINITION:

Probability that a randomly selected organism on a surface exposed to extra-terrestrial ultra-violet radiation will survive the dose applicable to the mission specific conditions.

APPLICABLE SOURCE:

All organisms on surfaces exposed to extraterrestrial ultra-violet radiation.

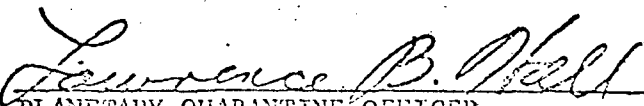
CONSTRAINTS: Selection of a particular value is to be made in two steps as follows:

1. Assuming complete exposure of the microorganisms, i.e., no shielding, P(uv) is determined from a log-log linear function vs time of exposure to extra-terrestrial uv radiation. This function is determined by two points:  
(a) P(uv) = 1 for a time of exposure of one minute, or less, and  
(b) P(uv) =  $1 \times 10^{-4}$  for a time of exposure of one hour. P(uv) for times of exposure other than the above can be obtained by interpolation or extrapolation of these two points.
2. The value obtained in accordance with the above must be increased to allow for the effects of shielding by structures or by small particles such as dust and debris.

These data were derived assuming the use of heat sterilization. If processes are proposed that do not include heat, the values must be reassessed to assure applicability for the proposed usage.

REFERENCES:

PQAP review on January 18-19, 1972 at Cape Kennedy, Florida.

  
PLANETARY QUARANTINE OFFICER

MAR 2 1972

DATE

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P(vt)

SYMBOL

ALL

MISSION SPECIFIC

1.0

UPPER

1.0

ACCEPTABLE

SS

1.0

LOWER

PLANETARY QUARANTINE PARAMETER VALUE

PARAMETER TITLE: Probability of Survival of Surface Organisms Exposed  
to interplanetary Vacuum - Temperature Environments.

PARAMETER DEFINITION: Probability that a randomly selected organism on the  
surface of a spacecraft will survive exposure to the combined environments  
of interplanetary vacuum and spacecraft temperatures.

APPLICABLE SOURCE: All organisms on the interplanetary spacecraft surfaces.

CONSTRAINTS:  
NONE

REFERENCES: PQAP review on March 24, 1972 in Atlanta, Ga.

PLANETARY QUARANTINE OFFICER

April 2, 1972  
DATE

NOTE: THE ABOVE DATA SUPERCEDES PREVIOUSLY PUBLISHED DATA ISSUED BY THIS  
OFFICE. PARAMETER VALUES DERIVED AS STATED ABOVE WILL BE ACCEPTED  
BY THE PLANETARY QUARANTINE PROGRAM IF USED IN THE MISSION P.Q.  
ANALYSIS AS DEFINED HEREIN.

$P_B$ (re|s)  
SYMBOL

MARS  
MISSION SPECIFIC

UPPER

$1 \times 10^{-4}$   
ACCEPTABLE

LOWER

PLANETARY QUARANTINE PARAMETER VALUE

PARAMETER TITLE:

PROBABILITY OF RELEASE BY EROSION OF ENCAPSULATED (BURIED)  
MICROORGANISMS UNDER SOFT LANDING CONDITIONS

PARAMETER DEFINITION:

Assuming soft landing of a spacecraft on Mars, probability that a randomly selected buried microorganism within a defined source, will be removed from that source by aeolian erosion and deposited on the surface of the planet in a viable state.

APPLICABLE SOURCE:

All microorganisms encapsulated within non-metallic spacecraft materials.

CONSTRAINTS:

This value was derived assuming the use of heat sterilization. If processes are proposed that do not include heat, the value must be reassessed to assure its applicability for the proposed usage.

This value is based upon environmental conditions predicted by preliminary results from the Mariner 9 mission. The value of this parameter may have to be revised on the basis of further results from the Mariner 9 mission.

REFERENCES:

PQAP review on January 18-19, 1972 at Cape Kennedy, Florida.

  
PLANETARY QUARANTINE OFFICER

DATE

MAR 2 1972

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